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TREATMENT OF BONE CAVITIES
BY FILLING WITH
COPPER AMALGAM

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LATE ASSISTANT ON THE SURGICAL STAFF, MOABIT HOSPITAL, BERLIN

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THE TREATMENT OF BONE CAVITIES BY FILLING WITH COPPER AMALGAM.¹

THE short time allotted to me prevents a review of all the work that has been done in regard to healing bone cavities. I shall only call your attention to some experiments I have made in the Moabit Hospital, in Berlin, during my time of service on the surgical staff, with a view of obliterating bone cavities, by means of plugging the cavity with inorganic material, following in the main the manner in which dentists fill carious teeth.

After attending a lecture of Professor W. D. Miller, delivered before the Association of American Physicians, in Berlin, where the pathological conditions of carious teeth were demonstrated, and the properties and antiseptic actions of some fillings explained, it occurred to me that some of these metals could be used in bone filling in place of other materials I had experimentally tried.

That foreign bodies can become encapsulated within soft tissues, as well as in bone and even vital organs, is an established fact, which we often witness in gunshot wounds when the bullet is allowed to remain, although we do not know the exact process under which encapsulation takes place.

Although the conditions upon which the permanent encapsulation of fillings into bone depends are by no means so simple as in the case of carious teeth, the investigations and experience of the dental profession must, of course, form the basis of our experiments.

Above all, it was clear that the material used for fill-

¹ Read before the Surgical Section of the Pan-American Medical Congress Meeting, in Washington, D. C., September 5-8, 1893.

ings must be not only aseptic, but actively antiseptic, since it is certainly out of the question so to disinfect at one sitting the cavities which remain in the bones after chronic osteomyelitis or tuberculosis that all the bacteria in them are destroyed. If the filling is to become encapsulated it must, by virtue of its antiseptic properties, act upon the colonies of micro-organisms which may still be present, and thus destroy the exciting causes of the inflammation. Furthermore, such fillings must consist of a material which is light, non-poisonous, and hardens rapidly.

I am encouraged to make the present demonstration because of the interest a former presentation aroused at the Twelfth Congress of German Surgeons, and because I am desirous that the investigations so far made may be tested by others, and perhaps brought nearer to completion. For, although the question whether such fillings can heal within bones will soon be definitely answered, it will require years of observation to ascertain whether this method of bone-filling is to be regarded as an enrichment of surgical procedures.

Experiments were made with various metallic mixtures of as low a melting-point as possible, among others with the alloy of Wickersheimer, used for metallic corrosions of bones, which melts at 55° R. (156° F.), and the alloy of Lipp, which melts at 63° R. (174° F). But it soon became evident that these mixtures could not be of service, as they solidified in the funnel, and even if no funnel is used, the mixture does not flow properly if poured into a cavity which is below the above-mentioned temperatures. Attempts were made to transform aluminium into a soft mass, but as yet without success. With mercury, aluminium forms a spongy, porous mass, such as has been noticed when instruments of that metal have been put into a solution of bichloride.

Copper amalgam was made into a dough-like mass, in the manner customary in dental practice, by heating it in a spoon over an alcohol flame and rubbing it to a pillular

consistency in a mortar. The cavity was either completely filled with the mass, or only coated with it, and a lighter filling material, a cement, gutta-percha, etc., used to fill out the defect. Plaster of Paris¹ (after Trendelenburg) at first was not used, because it is more porous and heavier than the above-mentioned substances, and not so easy to manage; it also hardens more slowly, and is more liable to soil the surface of the wound. On account of the well-known instability of carbolic acid, it is not to be supposed that plaster-of-Paris fillings, made up with a five per cent. solution of carbolic acid, instead of water, will have any lasting antiseptic effect on the surrounding tissue. In one experiment, as we shall see further on, I used plaster of Paris after the cavity was coated with cotton amalgam, but as will be observed a great deal of shrinking took place.

Of cements the Harvard cement of Dr. Richter is particularly worthy of mention. I had made for my use a quantity of the lighter white sort of this cement, which shows the fewest pores. It also requires a much shorter time for hardening than any other cement, and shows no shrinking after hardening. On account of the expense of the latter I have set to work and experimented with a number of different cements and putties, and found that one of the most reliable cements, and at the same time very inexpensive, could be obtained in the oxychloride of zinc. I used this in my later experiments in connection with the copper amalgam. Its preparation is as follows: Zinc chloride, 4 parts; aqua dest., 5 parts; glycerine, 3 parts. Of this solution 10 c.c. is intimately mixed on a slab, by means of spatulas, with 10 gm. of oxide of zinc. It will remain in a pasty condition for about four to five minutes and then set, and show, upon being split with a hammer and chisel, none or very fine pores. Use was also made of Abbey's non cohesive goldfoil, the antiseptic effect of which had already been shown by Miller.

On account of the troublesome technique to properly

¹ Dreesmann; Knochenplombirung, Beitr. z. Klin. Chir., ix., Heft 3.

apply copper amalgam, the substance which shows the most marked antiseptic effect on plate cultures of bacteria, I made use, in some experiments on animals, of coarse filings instead of the dough-like mass. The cavities were coated with this, and then filled out with cement, gutta-percha, etc. We shall see, after describing the post-mortem condition of the bones that underwent filling, which is to be preferred.

The property of copper amalgam to check the development of various sorts of pathogenic and non-pathogenic bacteria has already been shown by Miller,¹ even in the case of fillings of this metal, which had been carried for years in the teeth. This has since been confirmed by Behring,² in his article on the means and methods of disinfection, and I have been able to show a direct antiseptic effect by the death of bacteria in plate cultures. I prepared, in the usual way, plate-cultures on agar agar of bacteria (*staphylococcus aureus*, *staphylococcus albus*, etc.), and after the colonies were fully grown placed a copper amalgam filling on the plate. Before putting in the fillings inoculations were made from the plates on agar tubes, and after twenty four hours other inoculations were made from colonies within a space of 1 to 2 ctm. from the edges of the fillings. In spite of many attempts, nothing ever grew except in the tubes inoculated before the fillings were put on the plate.³

It is worthy of note that the greenish discoloration appears much sooner and more markedly, and spreads over a larger space, if the metal is put on a plate on which the cultures are already grown than if it is put on immediately after the preparation of the plate. In the latter only a narrow green ring is formed around the filling; perhaps the more extensive discoloration is due to the

¹ Mikroorganismen der Mundhöhle, 2. Aufl., 1893, p. 277.

² Desinfection, Desinfectionsmittel, und Desinfectionsmethoden, Zeitsch. f. Hygiene, Bd. ix.

³ Since the above was in print I have learned from Professor Miller that he has also confirmed the above results by experiments on the pulp of living teeth.

chemical changes produced by the bacteria. Copper amalgam of various manufactures were used, and at one time it seemed that some possessed more marked antiseptic properties than others, but this was a result obtained during the time my incubator was out of order, and shows that if the plates are exposed to ordinary room-temperature the free space surrounding the copper amalgam will be much larger than when the plate-cultures are at once transferred to the incubator that registers 37° C.

The animal tests were made on dogs, some of which were operated on at one, others at two sittings. In order to get the filling closely into the bone defect it is desirable to have the cavity as dry as possible. In this case we are confronted with considerable difficulties with which the dentist does not have to combat, for we have to deal with a tissue richly supplied with blood, while the dentist has only to excavate the tooth, dry it with the hot-air blast, and separate it from the mouth with rubber sheeting, in order to obtain a perfectly dry surface, such as we cannot obtain even with the tampon and the Es-march constrictor. I have made use of the hot-air blast, and after considerable modifications I had constructed a hot-air blast by which a steady stream of hot air of 70° to 80° C. is obtained. It consists of a spiral platina loop, 20 ctm. long, which is lighted by an accumulator supplied with forty cells. It works very much on the style of a Paquelin thermo-cautery, a continuous supply of air being driven through the platina loop by a double blast. Before drying out the cavity with this I swab with alcohol and ether in order to facilitate the drying. Pressing in the filling will cause a slight capillary hemorrhage, not enough, however, to cause any disturbance.

EXPERIMENT I.—Bitch, aged six months. In morphine narcosis the upper epiphysis of the left tibia was chiselled open, the periosteum being also taken away and the medullary portion gouged out with a sharp spoon.

The hemorrhage was checked by tampons, swabbing with alcohol and ether, and use of the hot-air blast, and the cavity was coated with prepared copper amalgam. During the filling a little blood had to be occasionally wiped out. The hollow of the filling itself was not filled out. Edges of wound closed with catgut sutures and a plaster-of-Paris bandage applied. The next day the bandage was found gnawed off and the stitches torn open. Another bandage was applied, but as this also was torn off and the wound began to secrete, no further attempt at bandaging was made. By the third day after operation the animal used the operated leg for standing and walking, and jumped into his stall without difficulty. The wound closed completely in eighteen days. On the twelfth day the depression in the filling was still visible through a little opening. Forty-four days after the operation the animal was killed. Wound of incision completely cicatrized and of a reddish appearance, plainly recognizable. Inner side of tibia, where it was chiselled open, shows marked thickening; no fistula present. On sawing the bone through longitudinally it appears that the filling has been made smaller by the formation of new parosteal bone-tissue, the newly formed bone-tissue having pressed upon it until the hollow which was in the filling has entirely disappeared. Only a slight crescent-shaped form shows that the filling originally filled around bone defect, or rather covered it as a thin coating, leaving the middle of the cavity entirely empty. The surface of the section of bone in the neighborhood of the filling is somewhat darkened and discolored by the saw-dust produced by sawing through the copper amalgam.

EXPERIMENT II.—Bitch, six months old. In morphine narcosis the same operation was performed as in the former experiment, except that a filling of the Harvard cement of Dr. Richter was used instead of copper amalgam. Progress of the healing about the same; after fifteen days the outer wound is entirely closed. Animal killed in forty-four days. The tibia shows marked thick-

ening over the site of the filling. No fistula. On sawing through, the filling is seen to be completely healed in. In this case also the sawed surface in the neighborhood of the filling shows some yellowish discoloration, due to the sawdust from the cement.

EXPERIMENT III.—Dog, eight months old, operated on in two sittings. In the first sitting the bone was chiselled open in morphine narcosis, the medullary portion removed with a sharp spoon and a tampon of sterilized gauze inserted. Operation the following day, without narcosis. Tampon removed, the cavity lined with a coating of softened copper amalgam and then filled with Richter's Harvard cement. Soft parts sutured with catgut and bandaged. Bandage several times renewed, but always gnawed off; progress of the healing slower than in the preceding cases. In this case there existed a deep fistula, through which the filling can be felt with a sound. The filling, however, seems to be firmly healed in. The fistula closes twenty-eight days after the operation, and the wound heals in the course of the next week. The animal is killed forty-three days after the insertion of the filling. In the soft parts the cicatrized fistula may be easily distinguished from the rest of the scar tissue by its more reddish color. The tibia being freed from the soft parts, a not yet calcified spot may be recognized as the former bone fistula; it is, however, completely covered with thick granulations, which is connected on the inside with the bone tissue. It is much more difficult to saw through the bone in the region of the filling than in the preceding cases. After the bone is sawed through it is seen that a small portion of the gauze had been left in the cavity. The filling is considerably broken up, which I explain as the effect of the pulling of the saw teeth, which were clogged with shreds of gauze on the filling, which was not firm enough to stand such violent treatment. In this case also the neighborhood of the filling is discolored by the amalgam.

The next experiments were carried on to determine

how older animals would stand the operation of bone-filling, and whether they would become perfectly encapsulated, as also to find out which was the better technique—filling with softened copper amalgam or that with coarse filings of the metal.

EXPERIMENT IV.—Dog, eight years of age, sixteen pounds. In morphine narcosis the tibia is chiselled open, as in the previous experiments. Instead of softened copper amalgam, the coarse filings are used, with Harvard cement. After sixty days the animal is killed. The defect in the bone over the site of the filling is partly closed with new bony tissue, partly with granulations. A fine sound cannot be passed through anywhere. After sawing the bone open, longitudinally, it is seen that the filling is somewhat torn. This seems to show that the filling does not fit as tight when the filings are used instead of the softened metal, as we witness this tearing of the filling in every case where the former was used.

Five more experiments were made with older animals, and while all the fillings remained in and the wound became smaller, not enough time elapsed between the date of operation and the day the animals were killed to be definite as to the time required in old dogs to become perfectly encapsulated.

So much in regard to the experiments thus far made. In addition to the successful experiments just reported, Professor Sonnenburg has made use of the method of bone filling, proposed by me, on two patients suffering with chronic osteomyelitis, and while they were unsuccessful they still offer a great deal of interest, and show that, if properly made, a filling can become encapsulated. The operations were made at a time when the technique was anything but well tried. Again, it shows that no one should attempt bone-filling in the above manner with copper amalgam until after he has practised it either on the dead or lower animals, and acquainted himself thoroughly with the different manipulations. *There is a decided difference between simply filling a hole in*

a bone and the proper adjustment of a filling to a bone cavity.

One filling came out after two months ; it had been tightly seated for about fourteen days, when it became loosened and was gradually expelled. Right behind the filling was found a sequester, about one-fourth of an inch broad and one inch long, which evidently had been overlooked at the time of operation. The filling itself, as will be observed, is rather irregular ; instead of being evenly covered with copper amalgam, the latter has been crowded on to one position. It will be seen that on one side newly formed bone-tissue is closely attached to the metal and cement. As these cases will be reported by Professor Sonnenburg I shall not lose time in dwelling upon them here. One case of bone-filling for chronic osteomyelitis, of ten years' standing, in which I have inserted a filling weighing approximately 120 gm. (4 oz.), has been left to me by Dr. Rieger, Director of the Surgical Department of the All Saints' Hospital, in Breslau. The results of this case will be published by the surgeon in charge as soon as definitely known.

No one is more conscious of the incompleteness of this work than myself, and in giving it I entertain hopes that those of you, gentlemen, who have material at their disposal will take up this subject, and reveal whatever merits or demerits it may possess and give the results whatever publicity they deserve.

In addition, I have tried copper amalgam in the treatment of chronic gonorrhœa by application of sounds covered with that metal.

Experiments are also in progress to see whether O'Dwyer's intubation tubes, covered with copper amalgam, have any direct action upon the primary focus in diphtheria, and are capable of preventing the downward spread of this disease.

